

NATIONAL JUNIOR COLLEGE
PRELIMINARY EXAMINATIONS
Higher 2

CANDIDATE
NAME

SUBJECT
CLASS

REGISTRATION
NUMBER

CHEMISTRY
Paper 2 Structured

9647/02

Fri 16 Sept 2011

Answer on the Question Paper.

2 hours

Additional Materials: Data Booklet

READ THE INSTRUCTIONS FIRST Write your subject class, registration number and name on all the work you hand in. Write in dark blue or black pen on both sides of the paper. You may use a soft pencil for any diagrams, graphs or rough working. Do not use paper clips, highlighters, glue or correction fluid. Answers all questions. The number of marks is given in brackets [] at the end of each question or part question.	For Examiner's Use	
	1	/12
	2	/13
	3	/13
	4	/16
	5	/18
	Total	/72

This document consists of **18** printed pages and **0** blank page.

1 Planning (P)

You are to design an experiment to determine the enthalpy change of solution of Mg(OH)_2 in water.



You are provided with the following data and a list of apparatus and reagents:

Data:Reagents:

- o 2.0 mol dm^{-3} of HCl
- o Mg(OH)_2 solid

Apparatus:

- o A thermometer with 0.2 °C division
- o A 100 cm^3 Styrofoam cup with a lid
- o Two 50 ml measuring cylinders

- (a) Suggest a reason why ΔH_{soln} of solid Mg(OH)_2 cannot be determined by measuring temperature change when a certain amount of solid Mg(OH)_2 is dissolved in water.

.....

[1]

- (b) Given that the enthalpy change of reaction between solid Mg(OH)_2 and hydrochloric acid is **approximately** -30.0 kJmol^{-1} ,

- (i) give the thermochemical equation of the reaction between solid Mg(OH)_2 and hydrochloric acid.

.....

[1]

- (ii) prove with calculations whether 50.0 cm^3 of 2.0 mol dm^{-3} HCl and 1.17g of Mg(OH)_2 are suitable quantities to work with.

[1]

- 1 (b) (iii) Hence give a detailed procedure to determine the enthalpy change of reaction between solid $\text{Mg}(\text{OH})_2$ and HCl solution accurately.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

[5]

- 1 (c) Given the following data, show how the enthalpy change of reaction between solid $\text{Mg}(\text{OH})_2$ and hydrochloric acid can be determined accurately.

	Expt
Mass of weighing bottle and solid sample / g	a
Mass of weighing bottle and residual solid / g	b
Initial temp of 50.0 cm ³ of hydrochloric acid / °C	T_1
Final constant temp of hydrochloric acid / °C	T_2 where $T_2 > T_1$

[1]

- 1 (d) By considering the data given and your answer to part (c), construct a suitable energy cycle that will enable you to determine the enthalpy change of solution of $\text{Mg}(\text{OH})_2$.

[2]

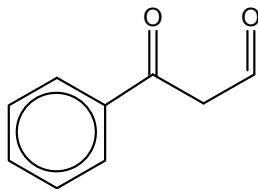
- (e) Suggest and explain a safety precaution for this experiment.

.....
.....

[1]

[Total: 12]

- 2 A student was given a sample of 3-oxo-3-phenylpropanal.

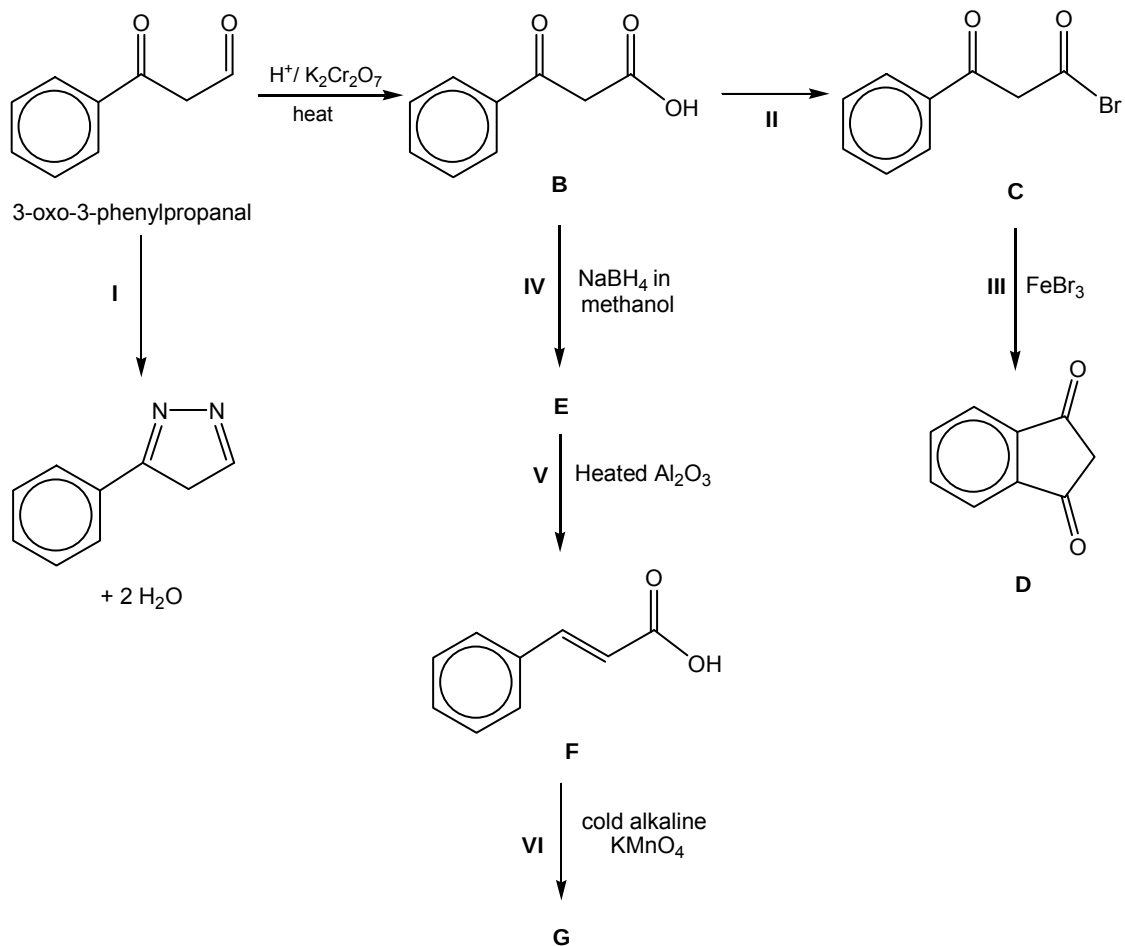


3-oxo-3-phenylpropanal

- (a) Describe what the student might observe when 3-oxo-3-phenylpropanal is warmed gently with Fehling's solution. Write an equation for this reaction.

[2]

- 2 (b) The student carried a series of tests on 3-oxo-3-phenylpropanal as follows:



- (i) State the reagents and conditions needed for

Reaction I :

Reaction II :

- 2 (b) (ii) Suggest the structures for **E** and **G**.

E	G
----------	----------

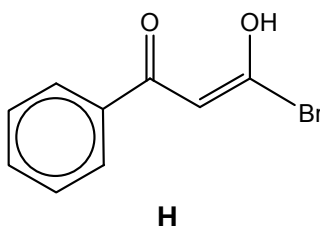
- (iii) Suggest a mechanism for reaction **III**. In your answer, show any relevant charges, lone pairs of electrons or movement of electrons you consider to be important in this mechanism.

[7]

- 2 (c) When **C** was added to an aqueous solution of silver nitrate, a cream precipitate was observed immediately.

(i) Write equations to show the formation of the cream precipitate.

- (ii) However, no precipitate was observed when compound **H** was heated with an aqueous solution of silver nitrate.



Suggest an explanation for the unreactivity of **H**.

.....

.....

.....

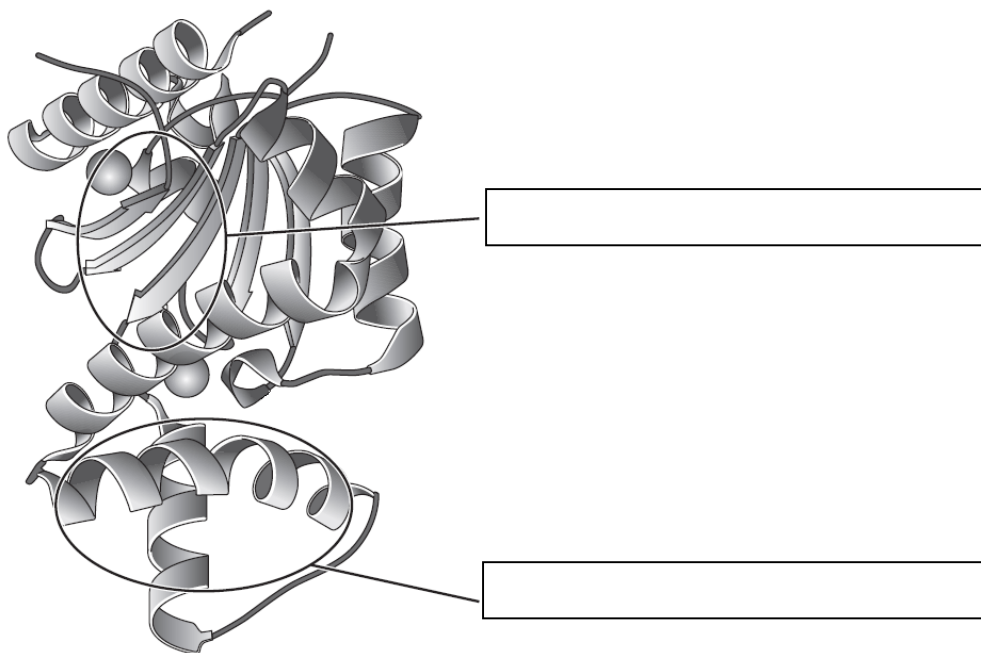
.....

.....

[4]

[Total: 13]

- 3 The diagram below represents part of the structure of a haemoglobin molecule.



- (a) (i) Write the names for each of the secondary structures in the boxes in the above diagram.
- (ii) With reference to the haemoglobin molecule, explain what is meant by the term *quaternary structure* of proteins.
-
-
-
- (iii) With the aid of a diagram, show the bonding that occurs to hold a polypeptide chain in its secondary structure.

[5]

3 (b) The following amino acids are found in the haemoglobin molecule:

Alanine: $\text{NH}_2\text{CH}(\text{CH}_3)\text{COOH}$

Serine: $\text{NH}_2\text{CH}(\text{CH}_2\text{OH})\text{COOH}$

Aspartic acid: $\text{NH}_2\text{CH}(\text{CH}_2\text{COOH})\text{COOH}$

Lysine: $\text{NH}_2\text{CH}(\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{NH}_2)\text{COOH}$

- (i) By considering only the amino acids above, describe, with the aid of diagrams, two side chain interactions involved in maintaining the tertiary structure of the haemoglobin molecule .

[2]

- (ii) There are three pK_a values associated with lysine: 2.2, 8.7, 10.5. Make use of these pK_a values to suggest the major species present in solutions of lysine with the following pH values.

(I) pH 1

(II) pH 5

(II) pH 9

For
Examiner's
Use

(III) pH 13

[4]

- 3 (c) The hydrolysis of a polypeptide chain consisting of ten amino acids produces the following fragments:

Val-Val-Ala
Glu-Gly-Asp-Phe
Ala-Glu
Ala-Val-Val-Val-Ala
Trp-Ala-Val

Deduce the sequence of the amino acids in the polypeptide chain by showing appropriate working.

[2]

[Total:13]

- 4 (a) Nitrogen dioxide, NO_2 , (from car exhaust fumes) can react with sulfur dioxide, SO_2 , (from the burning of fossil fuels) in the presence of water vapour in the atmosphere to produce sulfuric acid (acid rain) and nitrogen monoxide, NO . The nitrogen monoxide is rapidly re-oxidised to nitrogen dioxide by oxygen.

(i) Construct balanced equations for these two reactions.

.....
.....

(ii) Hence suggest the role played by nitrogen dioxide in the overall process.

.....
.....

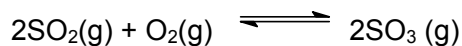
[3]

- (b) Selenium, Se , is in Group VI of the Periodic Table below sulfur. How would you expect the bond angle in selenium dioxide, SeO_2 , to compare with that of sulfur dioxide, SO_2 ? Give your reasoning.

.....
.....
.....
.....

[2]

- 4 (c) In Singapore, nearly all the sulfuric acid is manufactured in a series of steps, starting with sulfur. In one of these steps, sulfur dioxide is oxidised in a reversible reaction.



- (i) In a research laboratory, a chemist was developing improvements to this process. The equilibrium partial pressures of $\text{SO}_2(\text{g})$ and $\text{SO}_3(\text{g})$ at 27°C are shown in the table below.

Gas	$\text{SO}_2(\text{g})$	$\text{SO}_3(\text{g})$
Equilibrium partial pressure/ kPa	32	35

- (I) Given that the total pressure is 110 kPa, calculate K_p for this equilibrium, giving your answer in 3 significant figures.

- (II) Calculate the total volume occupied by the equilibrium mixture when 20.5 mol of SO_2 is present at equilibrium.

- (III) Predict and explain how the position of the equilibrium might change if vanadium(V) oxide catalyst is added into the system.

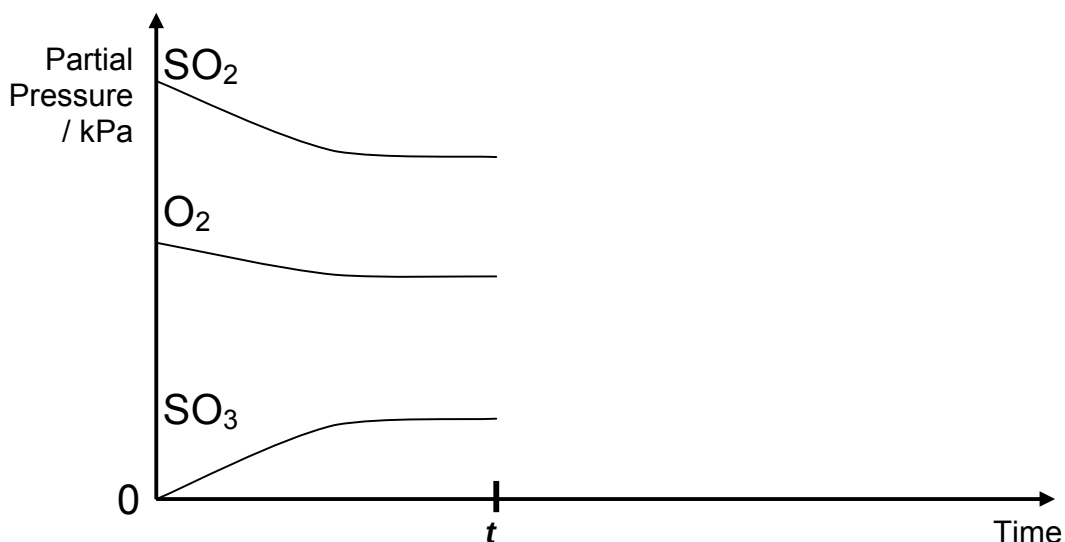
.....

.....

.....

[6]

- 4 (c) (ii) At 40°C, the chemist continued his investigation on a new mixture of SO₂(g) and O₂(g) by monitoring the changes in partial pressures of the individual gases. After the system reached equilibrium, he compressed the volume of the system at time t .



Sketch on the graph above to show how the partial pressures of individual gases will change when the chemist compressed the volume of the system at time t , which was maintained at 40°C. Label the graph extensions for each species till equilibrium is reached at t_2 .

[3]

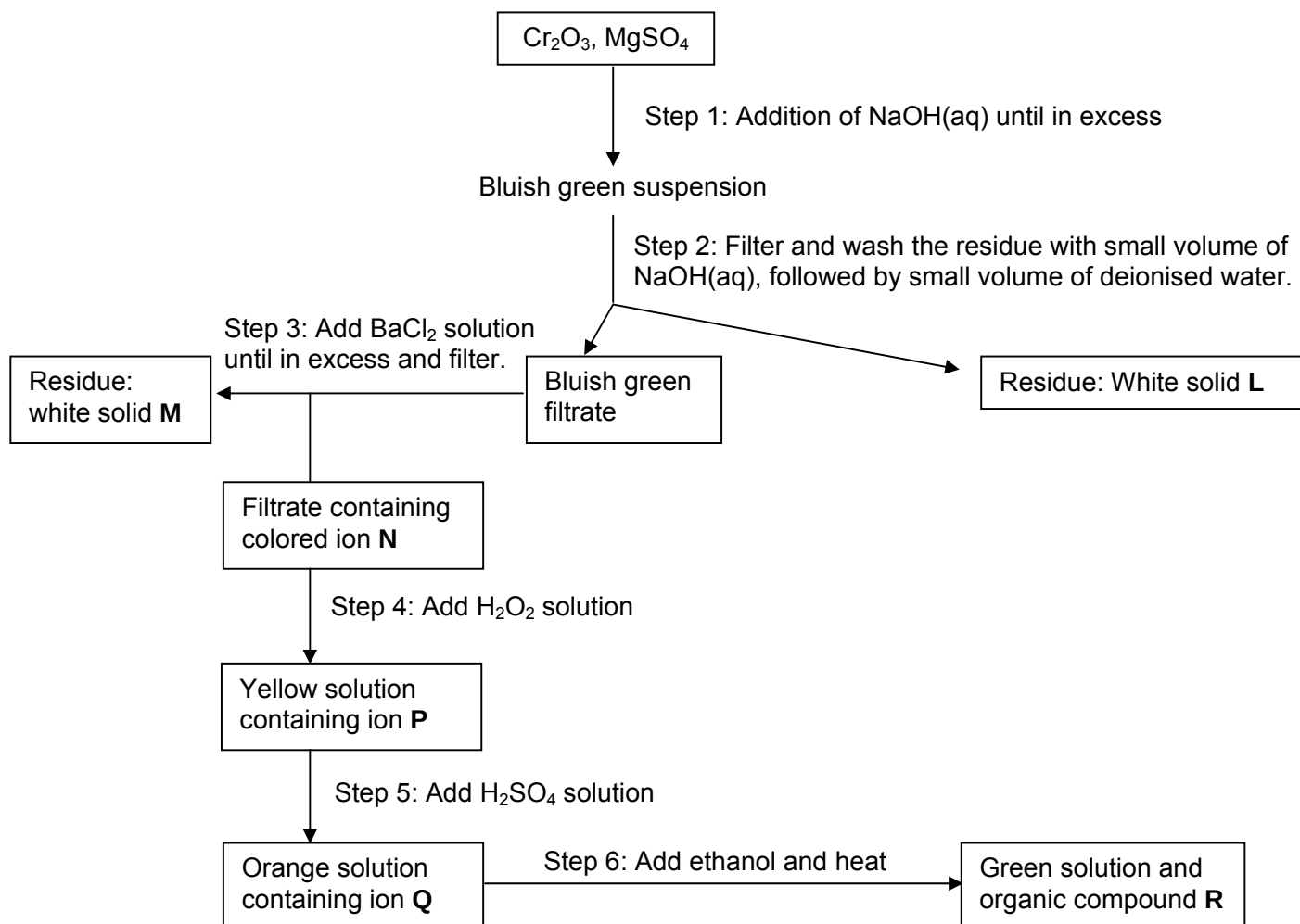
- (iii) Each year, about 1×10^6 tonnes of sulfuric acid are prepared starting from sulfur. Because any unreacted materials are recycled, the overall percentage yield of H₂SO₄ is nearly 100%.

Calculate the mass of sulfur required to produce 1×10^6 tonnes of sulfuric acid annually. Assume that the overall percentage yield of H₂SO₄ is 100%. (1 tonne = 1000 kg.)

[2]

[Total:16]

- 5 The following flowchart summarizes a series of steps undertaken to separate the chromium, magnesium and sulfate ions in a solid mixture containing chromium(III) oxide, Cr_2O_3 , and magnesium sulfate, MgSO_4 .



(a) Identify the species L to R.

L:

M:

N:

P:

Q:

R:

For
Examiner's
Use

[6]

- 5 (b) Cr_2O_3 can also react with aqueous H_2SO_4 to form a soluble salt. Identify the chemical property exhibited by Cr_2O_3 and explain why it behaves in this way by referring to the nature of the oxide formed.

.....

.....

.....

.....

[2]

- (c) Suggest and explain the importance of washing the residue with aqueous NaOH , followed by deionised water in **Step 2**.

.....

.....

.....

.....

[2]

- (d) Given that $E^\ominus$ value of $\text{R} \rightarrow \text{ethanol}$ is $+0.65 \text{ V}$, quote relevant data from the *Data Booklet* to prove the feasibility of the reaction in **Step 6**.

.....

.....

.....

.....

[2]

- 5 (e) Suggest and explain why only **Step 6** needs to be carried out under elevated temperature.

.....
.....

[1]

- (f) Given that the boiling points of ethanol, water and the organic compound **R** are 78°C, 100°C and 120°C respectively,

- (i) Explain their difference in boiling points.

.....
.....
.....
.....
.....

- (ii) Suggest how compound **R** can be isolated and collected from the product mixture obtained from **Step 6**.

.....
.....

- (iii) Suggest why anhydrous calcium chloride is added to compound **R** after carrying out the step in part **f(ii)**.

.....
.....

[5]

[Total: 18]